The Monetary Policy Transmission Mechanism and Policy Rules in Canada

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The inflation targeting regime in place in Canada requires a clear understanding of the monetary policy transmission mechanism and a way to exploit knowledge of that mechanism in making policy decisions. This paper describes the Bank of Canada's current understanding of the monetary policy transmission mechanism as well as our research, in the context of a model based on that understanding, to identify policy rules to help guide the formulation of monetary policy.

Section 1 discusses the Bank's view of the monetary policy transmission mechanism in Canada. It begins with the major linkages and then focuses in turn on transmission through financial variables, the impact of financial variables on aggregate demand, and the impact on inflation from the output gap, expectations, and the exchange rate. Because of the importance of inflation projections in the framework used at the Bank of Canada, section 2 reviews the range of approaches that have been investigated for generating such projections. These include the construction of small models of the Canadian economy, single-equation models of quarterly inflation, and a fully specified model, the Quarterly Projection Model (QPM). Section 3 outlines recent work at the Bank of Canada on policy rules. This section covers the QPM policy rule, simulation analyses comparing forward-looking

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rules of the QPM type with Taylor rules, and some ongoing work on open-economy extensions of Taylor-type rules. Given that some of this work suggests that efficient policy rules can be affected by particular changes in economic behavior, section 4 outlines some evidence on such changes in Canada since the introduction of an inflation target. The final section concludes.

1. The Canadian Monetary Policy Transmission Mechanism

The monetary policy transmission mechanism is complex, and our understanding of it is imperfect.[1] At the Bank of Canada our mainstream paradigm is quite explicit and well known and contains three major sets of linkages. The first major linkage is from our instrument, the target band for the overnight interest rate,[2] to other financial variables: the term structure of market interest rates, rates on deposits and loans at financial institutions ("administered rates"), and the exchange rate. The second runs from financial variables to aggregate demand and the output gap. And the third runs from the output gap, the exchange rate, and inflation expectations to inflation.

The precise relationships that underlie these three linkages are probably not fixed. In particular, we find it important to bear in mind that the success and credibility of the monetary and fiscal policy frameworks will condition the way the transmission mechanism works in practice. We also find it useful to have a checklist of the exogenous shocks that typically hit the economy (figure 1).

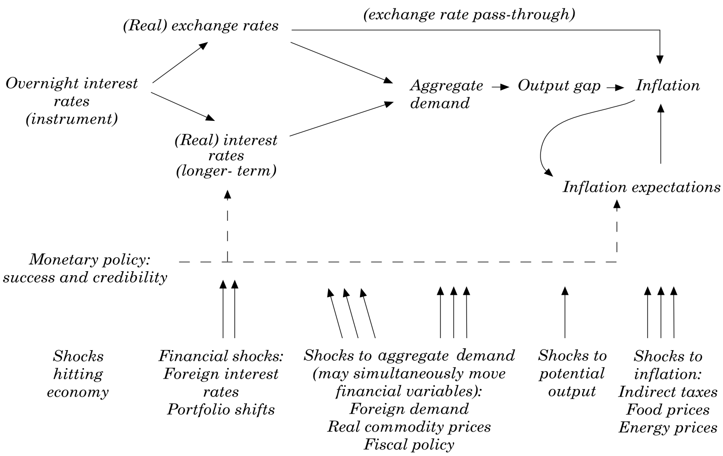
1.1 Transmission through Financial Variables

The Canadian term structure of interest rates is strongly influenced by the world term structure of real interest rates, risk premiums related to Canadian government debts and deficits (relative to those in the rest of the world), and domestic inflation expectations.

1. This section draws heavily on David Longworth's notes for a presentation on "Monetary Policy in Canada" to an IMF course in May 1997.

2. The target band for the overnight interest rate is 50 basis points wide, and the Bank aims to keep the rate in the middle of the band. Since February 1996, the Bank Rate, the rate at which directly clearing financial institutions borrow from the Bank of Canada, has been set at the top of the target band. Press releases are issued at the time of changes in the target band.

Figure 1. Monetary Policy Transmission Mechanism in Canada



However, it has generally been true in the past that a rise in nominal domestic short-term rates (and, more specifically in recent years, the target band for the overnight rate) has translated into a rise in nominal domestic rates all along the term structure, with the effects typically smaller the further along the maturity spectrum one is looking (see Clinton and Zelmer, 1997; Muller and Zelmer, 1999). One would expect, however, that this is due to the nature of the typical shocks experienced in the past. In the future, to the extent that a rise in short-term interest rates causes markets to raise their estimate of the probability of keeping future inflation within the inflation-control range, longer-term nominal interest rates may tend to fall or at least not rise.

Bank research has concluded that there has been an essentially stable (if not precise) relationship between administered interest rates (those set by deposit-taking financial institutions on loans and deposits) and market rates of similar maturities (see Clinton and Howard, 1994; Hendry, 1992). Moreover, the long-run relationship is one in which changes in administered rates move one for one with changes in similar market rates. And the adjustment is quite rapid—indeed, typically much more rapid than in the United States.

The exchange rate responds in an important way to unexpected changes in interest rate differentials between Canada and the other major industrial countries (Longworth and Murray, 1988; Khemani and Murray, 1990). Given Canada's trade patterns, the United States has a very high weight (about 86 percent) in the trade-weighted exchange rate index (Lafrance and Antia, 1998-99).

1.2 Impact of Financial Variables on Aggregate Demand

At the Bank of Canada, the mainstream transmission mechanism is one in which aggregate demand depends on two variables. The first is the level of real interest rates (relative to equilibrium real interest rates), which affects consumption spending (especially on durable goods), and which also affects decisions to invest in housing and nonhousing capital. The second is the level of the real exchange rate, which affects exports and imports in the usual ways.

The empirical evidence for Canada suggests that it is short-term (or perhaps short- to medium-term) interest rates that matter the most for aggregate demand. This evidence comes basically from four sources:

- reduced-form equations for changes in output, as well as for changes in exchange rates, in which interest rates of various maturities are important explanatory variables,
- reduced-form equations for changes in output using the spreads between long-term and various short-term interest rates (Cozier and Tkacz, 1994; Clinton, 1994-95),
- evidence from the structure of household and business balance sheets (Longworth and Poloz, 1995; Montplaisir, 1996-97), and
- evidence that the components of aggregate demand that move first in the business cycle are consumer durables and housing, which are typically financed with debt at short- to medium-term interest rates, rather than business investment.

The effects of interest rates and exchange rates on aggregate demand build up only slowly over time. There is little contemporaneous effect. But by the third or fourth quarter the effect is economically significant, with the maximum effect reached after six to eight quarters.

There is as yet little evidence that direct credit channels (see Bank of Canada, 1995) are important in affecting aggregate demand. But empirical and theoretical work is ongoing at the Bank on a direct money channel (Hendry, 1995; Armour and others, 1996; Engert and Hendry, 1998; Hendry and Zhang, 1998).

In addition to knowing how monetary policy affects aggregate demand, it is important to identify the major areas where shocks to demand will arise. For the Canadian economy, the major sources of shocks are foreign demand (particularly U.S. demand, given the structure of Canadian trade), domestic fiscal policy, and the real world price of commodities. Canada is a major net exporter of commodities, and thus its terms of trade tend to move in the opposite direction from other major industrial countries when real commodity prices change.

1.3 Impact on Inflation from the Output Gap, Expectations, and the Exchange Rate

As figure 1 shows, monetary policy affects inflation through three channels: the output gap, inflation expectations, and the exchange rate pass-through. A key part of the mainstream view of the monetary transmission mechanism at the Bank of Canada is the effect of excess demand or supply in product markets on the rate of inflation. Thus, changes in monetary conditions work through their effect on the output gap to influence the inflation rate over time.

As is well known, inflation expectations also play a very important role in the inflation process. Although there is evidence that the backward-looking component in these expectations remains important, the concentration of the central bank on the achievement of its inflation target no doubt helps to condition the formation of the forward-looking components of these expectations. And the achievement of the inflation-control targets means that the backward-looking component of these expectations will come to play a stabilizing role at a rate close to the targeted rate.

Another element in the short-run inflation process is changing relative prices. Arising from a number of sources, these can have once-and-for-all price-level effects and therefore influence the measured inflation rate in the short run, but not necessarily the momentum of the inflation process. Because monetary policy can influence the exchange rate, exchange rate effects are particularly important to note in this regard (see Laflèche, 1996-97). Other specific shocks that have been important in the past include shocks to indirect taxes, energy prices, and food prices.

The Bank of Canada has relied on the output gap channel to influence inflation (including the induced effect that the change in actual inflation thus produced exerts through the backward-looking element of inflation expectations). The Bank did not count on expectations being influenced by the target during the first few years of the inflation targeting regime. Nor has it relied on the exchange rate pass-through to consumer prices to guide inflation to its target (in strong contrast with the practice of the Reserve Bank of New Zealand in the early years of its inflation targeting regime). In principle, exploiting the effects of exchange rate pass-through could shorten the time necessary to hit the inflation target, but at the cost of greater volatility in the economy, including the volatility of real output. In recent years, as inflation expectations have become somewhat influenced by the targets themselves, exchange rate changes are now seen as affecting the price level, not the ongoing rate of inflation.

2. Inflation Projections

Although QPM is the main model and organizing framework for the medium-term projections that are constructed quarterly, both QPM and projections for inflation alone have been informed by a wide range of research with small models. These models have helped the Bank to better understand some of the workings of the economy, as well as to explore how to impose appropriate theoretical restrictions and grasp their implications. Thus, in moving from the overview of the transmission mechanism in the previous section to the description of QPM at the end of this section, it is useful to describe the range of approaches investigated. These include research with small, "complete" models of the economy, whether done as reduced forms, vector autoregressions (VAR), or vector error correction models (VECM); single-equation models of quarterly CPI inflation, which are generally Phillips curves; and models and methods that are useful in monitoring very short run monthly and quarterly movements in inflation (not discussed in this paper).

2.1 Small Models of the Canadian Economy

In the mid-1980s Longworth and Poloz (1986) constructed a small model to examine various policy rules. Its prominent feature was its simplicity: there were four behavioral equations (for output demand, a price Phillips curve, money demand, and the exchange rate) plus a policy rule and identities. Simplicity was desirable for a number of reasons. First, it allowed the model to be understood both by the modelers and by policymakers. Second, it allowed other key features to be put in place without too much difficulty: a coherent flow framework with a well-defined steady state, expectations that were model-consistent in the long run despite being adaptive in the short run, and exchange rate behavior that was consistent with convergence to the steady state. Third, simplicity made it possible to reduce the time required to do stochastic simulations. The model was calibrated (rather than estimated), based on judgment using estimates by the modelers and others. This meant that the modelers could concentrate on the effects of key variables and their parameters rather than have to expend considerable effort in the estimation phase of model building to control for all the variables that might matter in explaining a given endogenous variable. Thus, for example, the output equation excluded foreign output, real commodity prices, and fiscal variables. The framework of the four behavioral equations plus the policy rule captured the mainstream model of monetary transmission in which the real interest rate and the real exchange rate affected the output gap and thus inflation. It also set the stage for subsequent estimated reduced-form or VAR models, many of which omitted money variables, since the stock of money did not enter the equations for other variables.

For example, Duguay (1994) estimated a reduced-form IS curve for output, in which changes in Canadian output depend on lags of changes in the real interest rate, the real exchange rate, U.S. output, real commodity prices, and a fiscal policy variable. He also presented a short-run Phillips curve, based on the previous work of Dupasquier and Girouard (1992).

In the construction of the calibrated QPM model, as well as in subsequent work designed to calibrate stochastic shocks for use with QPM, a number of VARs were estimated by Bank staff. Finally, Armour and others (1996) have constructed a VECM in which the deviation of money from its long-run demand plays an important role. The model contains equations for Canadian output, prices, money (M1), and interest rates.

2.2 Single-Equation Models of Quarterly Inflation

The archetypical Canadian model of inflation would have the following form:

$$\begin{aligned} \textit{Inflation} = {} & \textit{Inflation expectations} + a\left[f\left(\textit{gap}\right)\right] \\ & + b\left[i\left(\textit{change in real exchange rate}\right)\right] \\ & + c\left[i\left(\textit{change in indirect taxes}\right)\right] \\ & + d\left[i\left(\textit{change in food prices}\right)\right] \\ & + e\left[i\left(\textit{change in energy prices}\right)\right] + \text{residual error}, \end{aligned}$$

where a, b, c, d, and e are parameters, f is a function, and L is the lag operator.

Equations have been estimated for the CPI, the core CPI (the CPI excluding food and energy and the effect of indirect taxes), the CPI excluding food and energy alone, and the CPI excluding changes in indirect taxes alone. Particular attention has been given to the formation of inflation expectations and to the measurement and relevant function of the output gap.

Until the last five years, most work at the Bank used inflation expectations that were modeled as backward looking, with the sum of the coefficients equal to one. (This was the case, for example, in Longworth and Poloz, 1986, and Dupasquier and Girouard, 1992.) But when inflation varies around a constant target, there is no longer a unit root in the inflation process. Then, as Thomas Sargent argued in the 1970s, it is inappropriate to model expectations with the unit restriction on the sum of the coefficients. As one moves from one inflation regime to another, one would expect a learning process, and thus quite a complicated formulation for inflation expectations. Initial steps in modeling such a learning process (as it applies to the actual evolution of Canadian inflation) have been undertaken by Laxton, Ricketts, and Rose (1994) and by Ricketts and Rose (1995) using a Markov switching process with three inflation regimes. Fillion and Léonard (1997) have used regimes similar to the ones captured in the Markov switching work in estimating a quarterly Phillips curve. Their model, which follows closely the archetypical model above, has inflation expectations in the current monetary regime that are close to 0.39 L(*inflation*) + 0.61(*inflation target*).

When the monetary authorities act to achieve a given inflation target range, inflation expectations at all horizons should eventually fall in line with that range. This reflects an increase in credibility and will likely need to be taken into account in projecting inflation (see Perrier, 1998; Maclean, 1998; Amano, Coletti, and Macklem,1999).

Potential output and therefore the output gap are not easily measured. The Bank of Canada has moved from estimating potential output as a linear trend, to constructing it using a Hodrick-Prescott filter on actual output, to estimating it using a multivariate filter that combines structural information with a filtering approach. The current procedure, which closely follows that of Butler (1996), decomposes potential output into the trend marginal product of labor, population, one minus the trend unemployment rate, the trend labor force participation rate, and trend hours worked, appropriately scaled by the trend of the labor share. Multivariate filters are used to estimate each trend. It is recognized that these filters have problems at the end of the sample period. St-Amant and van Norden (1997) discuss various approaches to measuring the output gap that have been used at the Bank and assess their strengths and weaknesses. Kichian (1999) assesses measures of potential output (and consequently the output gap) using state-space techniques on a model that includes a Phillips curve.

Until the 1990s, modeling at the Bank typically assumed that Phillips curves were linear functions of the output gap. Work by Laxton, Rose, and Tetlow (1993a, b, and c) attempted to estimate the degree of nonlinearity of the Phillips curve and to identify its implications. Their Monte Carlo studies showed that nonlinearities should be difficult to find. And their empirical work showed that a given degree of excess demand has a larger absolute effect on inflation than the same degree of excess supply. Dupasquier and Ricketts (1998a and b) extended this work by examining the empirical robustness of various theories on the curvature of the Phillips curve. They concluded that there is some evidence that the slope of the Phillips curve gets flatter at lower and more stable rates of inflation.

2.3 The Quarterly Projection Model

The Bank of Canada has long been interested in developing structural macroeconomic models and using them for economic projections.[3] In the late 1970s the RDuF (Research Department Experimental Forecasting) model became the organizing framework for the projection exercise. By the late 1980s, as the weaknesses of RDuF were becoming all too obvious, reduced-form aggregate demand and inflation equations were used to determine the important dynamics in the projection, which continued nominally to be performed with the RDuF framework. Then, in September 1993, QPM was introduced as the Bank's projection model.

The emphasis on structural models results from three main beliefs:

- that economic theory and empirical work suggest the major elements in the monetary transmission mechanism,

3. This section draws heavily on Longworth and Freedman (1995). See Duguay and Longworth (1998) for the history of macroeconomic models and their use in policymaking at the Bank of Canada.

• that there is enough stability in some of the major relationships in the economy that it is sensible to base an estimated or calibrated model on them, and

• that in order to conduct policy to achieve an inflation-control target (or other nominal target), it is necessary to have a way of quantifying the link between current changes in interest rates and future values of the targeted variable.

The use of structural models for economic projections has always been supplemented by judgment, particularly in the first few quarters of the projection. This judgment includes that based on information from variables that do not enter explicitly into the structural model, such as the monetary aggregates.

QPM, which built upon knowledge gained with reduced-form and VAR models, was designed to overcome the deficiencies of an earlier generation of models, including RDuF, by

• having a fully articulated, steady-state version of the model, to which the dynamic version converges,

• incorporating all necessary stock-flow relationships, with the key stocks being household financial wealth, the capital stock, government debt, and net foreign assets,

• basing household behavior on the Blanchard-Weil overlapping generations model, having firms choose the optimal stock of capital given the production function and the long-run labor supply, and having governments choose a desired long-run debt-to-GDP ratio, and

• incorporating both forward-looking ("model consistent") and backward-looking elements in expectations.

It is virtually impossible to impose all the desired long-run restrictions in an estimated model with forward-looking expectations where the data are drawn from a number of different monetary policy regimes. Therefore it was decided that the best of the second-best ways of assigning coefficients would be to calibrate the model, largely on the basis of existing empirical evidence.

Because of the way in which the model was calibrated (which depended to an important extent on the information on dynamics found in VARs), the short-run dynamics of the model are similar in many ways to models without stock-flow dynamics. To understand the short-run dynamics of the model, the key parts of the model (which are described more fully below) are as follows:

• aggregate demand, which depends importantly on interest rates and exchange rates
• the price-wage nexus
• the monetary policy reaction function, and
• the behavior of the exchange rate and the long-term bond rate.

The major aggregate demand components in the model are consumption (which includes housing and inventory accumulation), business fixed investment, government expenditure on goods and services, and exports and imports. In the short run, consumption is negatively related to the term spread between short-term and long-term interest rates. Business fixed investment responds to the cost of capital, and exports and imports are influenced by the real exchange rate.

The price-wage nexus in the model is somewhat complicated, as future prices and future costs appear in both equations. In setting prices, firms use lagged prices, forward-looking expected costs (including indirect tax effects), and forward-looking expected prices. Output gaps also affect inflation, and the relationship is nonlinear, with a given amount of excess demand having a larger absolute effect on inflation than an equivalent amount of excess supply. In addition to these factors, the CPI excluding food and energy depends on import prices, and thus on the exchange rate. Costs depend largely on nominal wages, which in turn depend on expected future prices, expected future nominal wages, lagged nominal wages, the real-wage target (determined by the equilibrium marginal product of labor), and the labor market gap.

The monetary policy instrument in the model is the short-term interest rate. This rate is determined by a monetary policy reaction function which expresses the yield curve gap-the difference between the short-term (three-month) and the long-term (ten-year) interest rate minus its equilibrium value—as a function of the deviation of inflation (based on the CPI excluding food and energy) from the inflation-control target six to seven quarters in the future. The reaction function also includes a lagged dependent variable to smooth the movement of the yield curve gap. The equation can be written as

$$yIeCdgDp_t = \alpha_1 \left[\sum_{k=6}^{7} \tfrac{1}{2} \left(\dot{p}_{t+k} - \dot{p}_{t+k}^{tar} \right) \right] + \alpha_2 \; yIeCdgDp_{t-1} \,, \qquad (1)$$

where $yieldgap_t = \left(i_t^s - i_t^l \right) - \left(i_t^s - i_t^l \right)^{ss}$, $\left(\dot{p}_{t+k} - \dot{p}_{t+k}^{tar} \right)$ is the deviation of inflation from its targeted rate, i^s and i^l are the short- and long-term interest rates, respectively, and *ss* denotes a steady-state value.

The ten-year interest rate is given by a weighted average of future short rates (adjusted by a term premium), the current short-term interest rate (adjusted by a term premium), and the foreign long-term interest rate (adjusted by a risk premium and the expected international inflation differential).

The exchange rate is determined by the uncovered interest parity condition, including a risk premium. In the long run the equilibrium real exchange rate adjusts so that the flow of net exports is sufficient to sustain the equilibrium net foreign asset position (which, in turn, is determined by household preferences, the desired stock of government debt, and the real interest rate).

3. Policy Rules

Svensson (1999) describes a monetary rule as a "prescribed guide for monetary policy conduct."[4] The rule reacts in a mechanical way to a prespecified information set. In reality, as discussed in Svensson (2001), central banks, in forming policy, consider all the information available about the economy, attempt to distinguish which shocks are occurring, and then modify their tactics and strategy accordingly.

A monetary rule is important for the policy advice provided to senior management as part of a model-based projection exercise. For each projection the staff at the Bank of Canada try to identify, in the context of a model, the various shocks affecting the economy and to quantify their impact on inflation. To provide consistent policy advice, it is necessary to have a systematic response of movements in the policy instrument to the various shocks. If the policy reaction function used by the staff continually changed, policymakers would be unable to differentiate between changes in the outlook stemming from shocks and those arising from changes in the policy reaction function. A stable reaction function provides a consistent link from projection to projection, to help in analyzing the implications of new information. Similarly, a benchmark policy reaction function provides

4. This section draws heavily from Amano, Coletti, and Macklem (1999), Côté and Macklem (1996), and Maclean (1998).

a baseline comparison for assessing the implications of different policy reactions (delayed, preemptive, and so forth). Such assessments are often provided, for example, in the alternative scenarios generated as part of the projection exercise.[5]

An ideal policy rule, as encapsulated in a reaction function in a model, is one that captures the central bank's general preferences in terms of bringing inflation back to target within an acceptable time frame, without causing unacceptable deviations in output from potential or unacceptable movements in the monetary instruments. (That is, there is an implicit loss function.) The rule should be one that performs well *on average*, rather than just with respect to one particular set of shocks. Much of the early work on monetary rules in QPM looked at model responses to deterministic shocks, mainly because the size of the model and the computing resources then available did not allow us to consider stochastic simulations. This early approach was followed in full recognition that the results obtained from deterministic simulations are highly dependent on the particular shocks imposed. More recently, Bank researchers have been using stochastic simulations, as well as analytic work based on small theoretical models, to examine whether we can improve on the current monetary rule in QPM.

3.1 The Initial (and Current) QPM Policy Rule

In a forward-looking model like QPM, the role of the monetary authority is to provide a nominal anchor for the economy. Because inflation expectations depend, at least in part, on future monetary policy, a policy rule needs to be specified in terms of an attainable nominal objective. Without an endogenous policy response to economic developments, economic agents do not have enough information to form their expectations, and nominal values become undefined (in other words, the model does not solve). An endogenous policy rule or reaction function is therefore an essential part of QPM. As noted above, QPM uses the short-term interest rate as the policy variable that has to adjust to achieve the inflation target.

Although this reaction function is an ad hoc rule, in the sense that it is not derived from an optimal control problem, the choice of parameters and the degree of forward-lookingness were chosen in

5. Longworth and Freedman (1995) discuss the role of the staff economic projection in the conduct of monetary policy.

the context of what we had learned in previous work or by experience. The six-to-seven-quarter horizon approximates well the sort of horizon over which monetary policy has a meaningful effect on trend inflation. Trying to hit an inflation target over a very short period of time would imply considerable volatility in interest rates (and the exchange rate), possibly leading to instrument instability. Even though the reaction function does not allow for secondary objectives other than smoothing of the policy instrument, the magnitude of the key parameter, α_1 in equation (1), which is linked to the degree of inflation volatility that the authorities are ready to accept, was also chosen taking into consideration that the authorities care about the volatility of output as well.

The use of a forward-looking rule implies that the monetary authority has knowledge of the origin and nature of recent shocks. In a model in which private agents are assumed to be (at least partly) forward-looking, it would be hard to argue that the authorities should not be characterized by the same behavior. Because there is a lot of uncertainty, QPM is built with enough flexibility to allow the implications of different policy responses to be considered by changing the reaction function in various ways.

3.2 Forward-Looking versus Taylor Rules

Reaction functions, like that in QPM, that involve adjusting interest rates to the expected future deviation of inflation from its target level are considered to belong to the class of inflation forecast-based (IFB) policy rules. Although these rules can allow for interest rate smoothing (as in QPM) or include other terms, such as the contemporaneous output gap as discussed below, their main distinguishing feature is their forward-lookingness with respect to inflation.

Reaction functions in which interest rates respond both to deviations of inflation from its target level and to deviations of output from potential, but using only contemporaneous or past information, are considered to be Taylor-type policy rules (Taylor, 1993). The original Taylor rule was derived for the United States, a closed economy, but it can be extended into an open-economy form as shown by Ball (1999) and Srour (1999) and discussed below.

Black, Macklem, and Rose (1998) use a model of the Canadian economy called CPAM (Canadian Policy Analysis Model), which has many of the features of QPM but simulates much faster, to investigate the consequences of variants of these two types of policy rules as well as a price-level rule.[6] They first examine the stochastic behavior of the economy, drawing random shocks from those identified with VAR analysis. They find that the base-case CPAM reaction function produces inflation outcomes considerably better than historical outcomes, although roughly in line with the experience in Canada since 1992, when inflation targets came into effect. When these authors compare alternative parameterizations of IFB rules in terms of the root-mean-squared deviations (RMSDs) of inflation relative to the target and of the output gap, they discover rules that produce lower RMSDs of both inflation and output than the base-case rule. This result usually occurs for a more vigorous reaction to an expected deviation of inflation from the target, and therefore implies more interest rate volatility than the CPAMIQPM rule.

Their results highlight that, in an open economy, two channels exist through which the monetary authority can control inflation: the output gap and the exchange rate. These different channels produce IFB rules with quite different properties. Because the lags in the exchange rate channel are shorter than those through the output gap channel, the monetary authority can achieve substantially better inflation control using the exchange rate channel. This comes at the cost, however, of considerably greater variability in interest rates, the exchange rate, and output. Owing to the nonlinearity in the Phillips curve in CPAM (and QPM), the higher variance of output also results in a lower level of output. Controlling inflation through the output gap has the advantage that stabilizing inflation requires leaning against the output gap, which both reduces output variability and raises the average level of output.

In their simulations of Taylor-type rules, Black, Macklem, and Rose find (as have others) "optimal" coefficients to be much higher than those suggested by Taylor's estimated rule characterizing historical U.S. Federal Reserve policy. They also find that Taylor rules produce results roughly similar to those of IFB rules if the comparison only focuses on the RMSDs of inflation and output. However, deeper analysis leads them to conclude that a Taylor rule is less appealing, for two reasons. First, it is not generally capable of achieving the inflation target on average in CPAM without an explicit modification to allow for a shift in the mean of output. Second, the

6. With respect to the latter type of rule, their results show a significant improvement in the trade-offs facing policymakers when they allow expectations to adjust to take account of the effects of price-level control.

volatility of interest rates is relatively high, sometimes high enough in absolute terms that a considerable proportion of observations have negative nominal interest rates. With IFB rules, where the dynamic structure of the model is taken into account, results are achieved with instrument settings that are much less volatile.

Recent work at the Bank of Canada by Dinah Maclean using stochastic simulations examines the performance of various policy rules from the perspective of their impact on inflation, output, and interest rate variability when the model economy is hit by stochastic shocks that approximate those that the Canadian economy normally experiences. Comparisons are made between the results from IFB-type rules, nonlinear rules that do not react until inflation falls outside the bands, and Taylor-type rules.

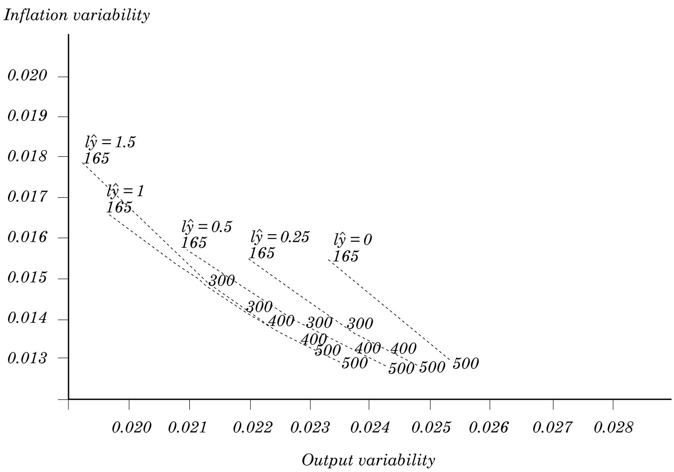
With respect to the IFB rules, the QPM reaction function described above is modified by adding a contemporaneous output gap term to the forward-looking inflation gap term.[7] The nonlinear rules allow for the possibility of no or very little monetary policy reaction as long as inflation is moving within the target bands. This is done by adding a term to reflect an additional weight on the deviation of inflation from its target six to seven periods ahead if inflation is outside the target band. The Taylor-type rules have the standard (closed economy) formulation. Various rules in each of the three basic classes are obtained by varying the weights on the inflation and output gap terms.

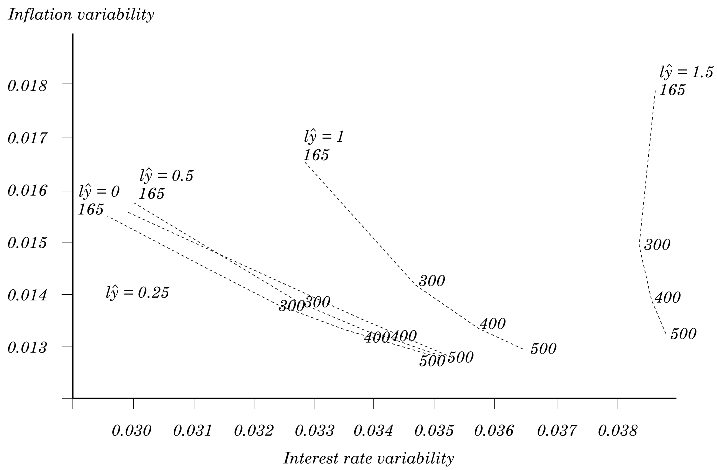
Each reaction function being considered is incorporated into QPM in turn, and stochastic simulations of the resultant model economy are run. The shocks used for the stochastic simulations are calibrated to be generally representative of the historical distribution of shocks affecting the Canadian economy. The results of the experiments are summarized in terms of output, inflation, and interest rate variability. Not enough simulations were run to determine which rule might be an optimal one, but the results provide some indicative evidence on the relative performance of each class of rule considered.

For illustrative purposes, figure 2 (taken from Maclean's work) shows the outcomes from simulating the various monetary policy rules. Each curve or locus shows the outcome for rules with the same weight on the output gap term and varying weights on the inflation gap term.

7. The inflation gap term looks six to seven quarters ahead, whereas the output gap term is an average of the contemporaneous output gap and one lag of the gap.

Figure 2. Simulations of Monetary Rules with Historical Distribution of Shocks[a]





Source: Bank of Canada.

a. $l\hat{y}$ is the coefficient on the output gap in the reaction function. The other numbers on the curves are 100 times the coefficient on the inflation term in the reaction function.

Outcomes are shown in terms of the variability of the deviations of inflation from target versus either the variability of the output gap or the variability of interest rates.

As the figure 2 shows, Maclean finds that, for relatively low weights on the output gap, increasing that weight reduces output variability without increasing inflation variability. This is the case, for example, in moving from a rule with a weight on the inflation gap of 1.65 and a zero weight on the output gap to a rule with the same weight on the inflation gap and a weight of 0.25 on the output gap. This is not true, however, for larger weights on the output gap, where more of a trade-off with inflation variability emerges. When the weight on the output gap reaches 1.5, output variability actually increases compared with a weight of 1. Too large a weight on the output gap term increases cycling in the real economy. For any given weight on the output gap, increasing the weight on the inflation gap (that is, moving along the locus) gives the expected clear trade-off between inflation and output variability.

With respect to the variability of inflation versus the variability of interest rates, when the absolute value of the weight on the output gap is small, the weight can be increased without increasing interest rate variability, but as the weight becomes larger, a clear trade-off starts to emerge. With respect to the former observation, increasing the weight on the output gap from zero to 0.25 reduces interest rate variability for all weights on the inflation gap. However, increasing the weight further, to 0.5, still leads to lower interest rate variability compared with the zero locus for many of the points.

Overall, Maclean's results support previous internal work at the Bank of Canada based on a stripped-down version of QPM with stochastic shocks. This work suggested that, by introducing a contemporaneous output gap term, the current rule can be improved in terms of reducing the variability of both output and inflation with little change in the variability of interest rates. To achieve this, there should be a greater weight on the inflation gap term than currently used in QPM and a small weight (rather than a zero weight as in QPM) on an output gap term.

The benefit of adding the output gap is that it allows the monetary authority to distinguish between price-level and demand shocks and thus to differentiate its policy response. Adding an output gap term into the rule does not mean that the monetary authority is targeting output. The role of the output gap is to provide more information to the monetary authority about the source of movements in inflation.[8]

Although adding an output gap term to a forward-looking rule appears beneficial, placing too great a weight on the output gap is a problem. It causes increased cycling in both output and interest rates, possibly because it shifts too much weight away from the forward-looking term (the inflation gap six to seven periods ahead). This result contrasts with the properties of a Taylor rule where both the output gap and inflation gap terms are contemporaneous. With such a rule, it is the output gap term that has the more forward-looking information. However, in comparing the forward-looking rule with a closed-economy formulation of the Taylor rule, Maclean suggests that Taylor-type rules do not do as well as forward-looking rules in terms of average variabilities. She makes it clear that this conclusion is tentative, because there was no attempt to search over a wide range of coefficients or formulations to identify the most efficient Taylor rule.

Maclean also shows that pursuing a more opportunistic policy, where the monetary authority does not react greatly to deviations of inflation from the midpoint if inflation is still within the bands, but only reacts when inflation is expected to fall outside the bands, will increase the probability of falling outside the bands. This suggests that the monetary authority should actively try to move inflation back toward the midpoint, even when inflation is within the bands.

Finally, initial results with regard to an interest rate smoothing term in the reaction function suggest that smoothing causes greater variability of inflation and output, although the costs of small amounts of smoothing are low. The variability of inflation can be reduced, with no increase in the volatility of the change in interest rates, by adopting a rule with greater smoothing and more aggressive weights on the gap. This comes at the cost, however, of larger changes in the level of interest rates, as well as greater output variability. Again, at low rates of smoothing the costs are relatively low. Some degree of smoothing is likely beneficial, therefore, and in fact the degree of smoothing suggested by these results is consistent with the smoothing already incorporated in the current monetary rule in QPM.

8. In exploratory work on the sensitivity of monetary policy rules to shocks, Bob Amano discusses how monetary policy would respond to an adverse supply-side price shock under a Taylor rule to demonstrate how the increased information provided by the output gap is helpful.

3.3 Open-Economy Extensions

Some analytic work on the implications of being an open economy for the form of the policy rule has been done at the Bank of Canada (Srour, 1999). Srour considers the role of the exchange rate in policy formulation, extending the work of Ball (1999).

Ball (1999) uses a very simple model with constant coefficients to show that the optimal policy rule in a small, open economy is similar to the Taylor rule. It differs from the Taylor rule in that it is not expressed in terms of the interest rate, but rather in terms of an index that is a weighted average of the real interest rate and the real exchange rate. The weights are roughly proportional to the coefficients of the same variables in the IS curve. In addition, the inflation rate is adjusted to filter out direct but temporary effects of the exchange rate.

Srour notes that Ball's results depend on the assumption that the shocks are white noise and, in particular, are uncorrelated across equations. He observes that this assumption is not valid in a small economy like Canada's, where variables such as commodity prices or foreign output affect both the exchange rate and demand. Therefore he extends Ball's model to include new exogenous explanatory variables, X_t, with the result that the optimal policy rule takes the form

$$\mathrm{Z}\, r_t + (1 - \mathrm{Z})e_t = \mathrm{A}y_t + \mathrm{B}(\pi_t + \mathrm{I}e_{t-1}) + \mathrm{C}X_t \ ,$$

where all variables are measured as deviations from their average values; $\mathrm{w}r_t + (1 - \mathrm{w})e_t$ can be viewed as a monetary conditions index (MCI), with r_t the real interest rate and e_t the log of the real exchange rate (defined such that a greater e_t means an appreciation); y_t is the output gap; $(\pi_t + \mathrm{f}e_{t-1})$ is a measure of inflation that excludes the direct but temporary effects of exchange rate movements, hereafter referred to as "core-core inflation"; w, A, and B are positive constants with $0 < \mathrm{w} < 1$; and C is a constant vector that depends on the parameters of the model excluding the coefficient on X_t in the exchange rate equation.

The implications for the response of the MCI to innovations in output or modified inflation are unaffected relative to Ball's model, since the effects of such innovations on future output and inflation have not changed. However, the MCI now must respond to innovations in X, since these will affect the future path of output and inflation. The extent to which the MCI must respond depends on the nature of the innovation.

Srour notes that an autonomous rise in the exchange rate would require constant monetary conditions, whereas a rise due to an increase in real commodity prices would require tighter monetary conditions. The reason for the latter response is that, other things equal, higher real commodity prices lead to more demand.

Bank of Canada staff would like to have a robust Taylor-type reaction function incorporating the extensions of Ball and Srour that could be substituted into QPM to generate results that would provide another perspective (to a model with an IFB reaction function) for internal discussions on monetary policy. A focused effort will be made to identify a suitable rule for this purpose. "Suitable" here means a reaction function that is robust across several models rather than one optimized for QPM only. Some preliminary simulation analysis is discussed below.

Exploratory simulation work at the Bank to date has considered a Ball-type open-economy Taylor rule and, for comparison purposes, two alternative formulations of the base Taylor rule, one using the core-core inflation measure and the other the core inflation measure. This work examines what happens to the responses of key variables under a standard set of shocks in deterministic simulations. It also examines what happens to the trade-off frontiers among the variances of inflation, interest rate, and output gaps when the weights on the output and inflation gaps in the reaction function are changed. For the latter simulations, the historical distribution of shocks to the Canadian economy was the same as that used by Maclean.

The exchange rate pass-through parameter is thought to be around 0.2 for core inflation. That is, a 1 percent depreciation in terms of the real exchange rate will result in a 0.2 percent increase in the price level after about eight quarters. The relative weight on the real exchange rate in the MCI in Canada is 0.33, versus 1.0 on the interest rate term. Note that although it is the yield spread gap rather than the real interest rate that affects real activity in QPM, other work at the Bank of Canada suggests that the relative weights on the real exchange rate and the real interest rate remain about the same in IS-curve estimations.

The measures of inflation and the output gap that are available for Canada are, or can be made to be, consistent with those in the theoretical models. A somewhat more difficult issue for an open economy that is not in equilibrium is how to measure the exchange rate gap, since the equilibrium exchange rate in the model's steady state is unlikely to be the relevant one for policy purposes. Since the theoretical models make no distinction in the exchange rate term for the pass-through effect and for the MCI term, the year-to-year change in the exchange rate was used in our reaction functions.[9] The reaction function was coded with the yield spread gap on the left-hand side and the real exchange rate, weighted by its MCI weight (0.33), on the right-hand side. The core-core inflation term was constructed using a parameter of 0.2 on the year-to-year change in the exchange rate.

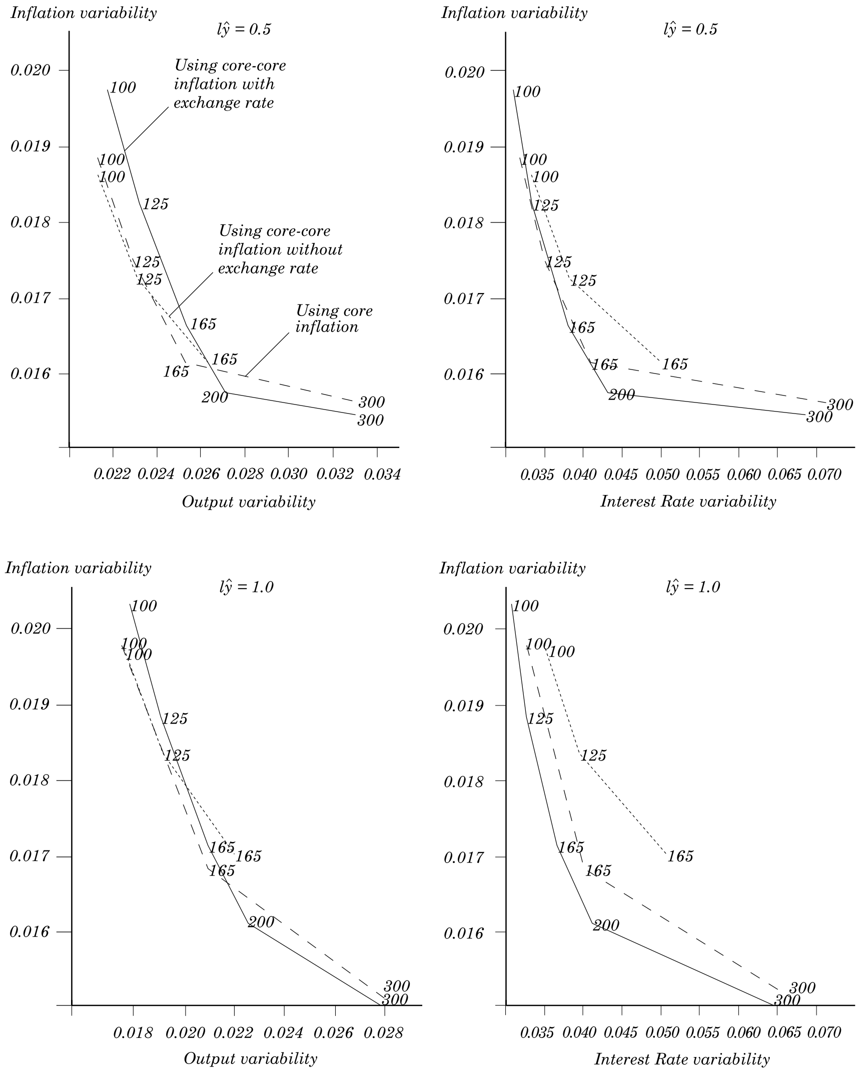
The initial experiments for variants of the Taylor rule were deterministic ones in which the standard simulations used at the Bank for assessing the implications of any change for the model's properties were undertaken to see how the model behaved under each form of the Taylor rule considered.[10] Although more work needs to be done to refine and understand the results, the most general observation is that the results from the open-economy Taylor rule show less cycling for inflation, interest rates, the exchange rate, and the output gap than do the results for the other two forms of the Taylor rule considered.

These results should not be all that surprising given the more complete representation, relative to the variants of the base Taylor rule used, of how policy is actually formulated and implemented in Canada. The results from the two other Taylor rules do not differ enough to allow us to say that either one shows less cycling than the other when all of the simulation results are considered. The next set of experiments were stochastic ones that used the same three versions of the Taylor rule as for the deterministic simulations and the representation of historical shocks used by Maclean. As is typical in this work, results were generated for a range of coefficients on the inflation gap term (0.5, 1.0, 1.25, 1.65, 2.0, 3.0, and 4.0) and for a range of coefficients on the output gap term (0.0, 0.25, 0.5, 1.0, and 1.5). Only selected results will be considered here. Results are plotted for the variance of inflation against the variance of the output gap and for the variance of inflation against the variance of the interest rate gap. In figure 3, each graph has three curves, corresponding to the three Taylor rules considered. Two sets of graphs are shown.

9. That is, the exchange rate lagged one year is used to represent the short-term equilibrium. It is not clear that this is the appropriate thing to do. In an artificial economy, the long-run equilibrium is always constant, so it might be better to use the level of e in calculating the MCI and the year-to-year change in e in estimating the exchange rate pass-through.

10. The following types of shocks are considered: a disinflation shock, an inflation shock, a demand shock, an exchange rate shock, a commodity price shock, a productivity shock, an indirect tax shock, a corporate tax shock, a government size shock, a government debt shock, and a foreign shock.

Figure 3. Simulations of Taylor Rules with Historical Distribution of Shocks and Low Exchange Rate Variability



Source: Bank of Canada.

Each set corresponds to a different weight on the output gap term l_y (0.5 and 1.0). The curves in each graph are constructed by joining the various points generated using the relevant output gap weight and a range of weights on the inflation gap term.

Figure 3 shows that using core-core inflation in the basic Taylor rule leads to a relatively worse (and more attenuated) trade-off frontier, especially for that between the variance of inflation and the variance of the interest rate, than either of the other two Taylor rules. It seems that using an underlying measure of inflation that removes the exchange rate effect without allowing the exchange rate to be directly considered in setting the instrument leads to a perverse dynamic. (Indeed, this dynamic ultimately causes the simulations to fail for larger weights on the inflation gap.)

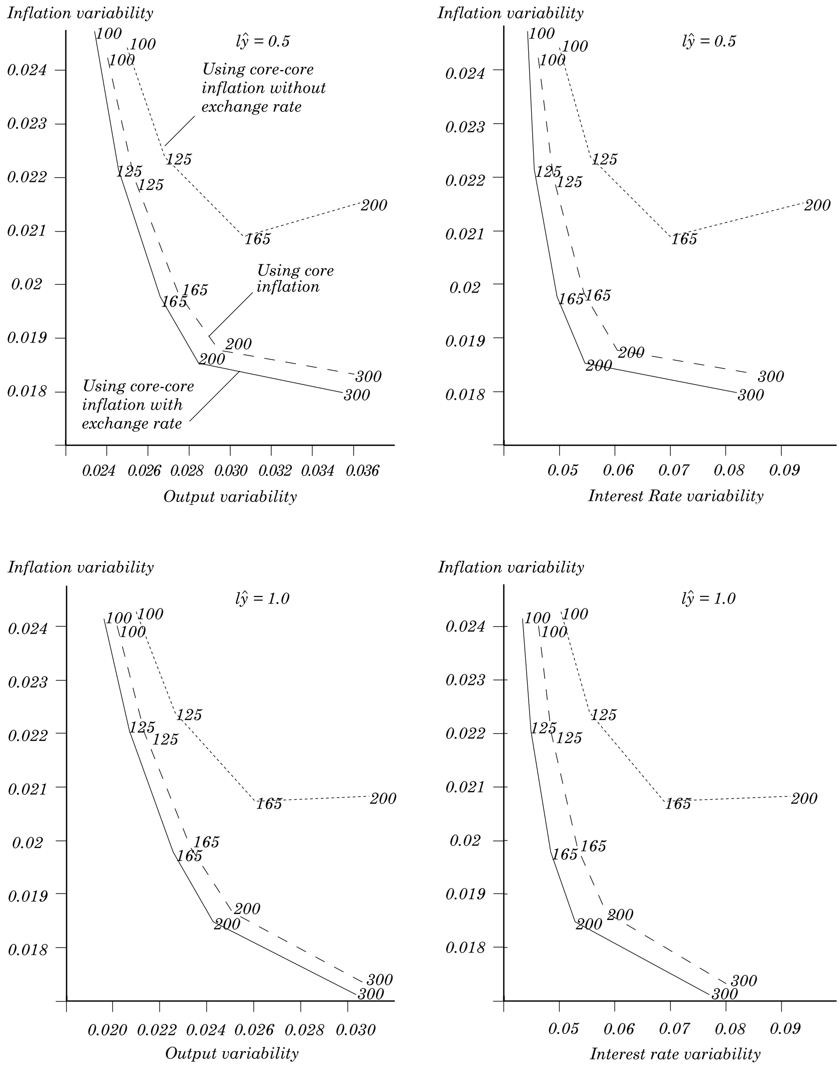
When movements in the exchange rate are taken into account as in the Ball-type open-economy Taylor rule, it seems that there might be some room for improving the relative performance of the trade-off frontiers from those obtained using a closed-economy formulation. With a higher weight (1.0) on the output gap, including the exchange rate does seem to reduce interest rate volatility (and presumably exchange rate volatility) and makes little difference for output variability.[11] However, this comes at the expense of greater inflation variability.

In calibrating the shocks to be used for stochastic simulations in Maclean's work and the preliminary investigations reported above, the variability of the exchange rate ended up below that seen historically. This trade-off was made to ensure that the variabilities of other key variables were consistent with historical experience. If the stochastic simulations are changed slightly to ensure that the resulting exchange rate variability is more in line with historical experience, the resulting trade-off frontiers, as shown in figure 4, are even more suggestive that it might be helpful to use a Ball-type open-economy Taylor rule.

Work at the Bank of Canada will continue to refine the conceptual underpinnings of an open-economy Taylor rule. At the same time, a concerted effort will be made, using simulation analysis and different models, to find a robust representation of a Taylor rule that can be used in the discussions on monetary policy formulation.

11. Exchange rate variability and interest rate variability resulting from these stochastic simulations are highly correlated.

Figure 4. Simulations of Taylor Rules with Historical Distribution of Shocks and Exchange Rate Variability as Experienced in Recent History



Source: Bank of Canada.

4. Policy Rules and Recent Changes in Economic Behavior in Canada

Economic behavior appears to have changed during the period over which inflation targeting has been in place in Canada in a way that has implications for our IFB policy rule. There is at least suggestive evidence of increasing monetary policy credibility (some of which is regularly reported in the Bank's semiannual *Monetary Policy Report*), a flattening of the Phillips curve, and greater room for countercyclical fiscal policy. The implications of each of these are addressed in Amano, Coletti, and Macklem (1999). They conclude that changes in credibility would require a recalibration of the IFB rule to avoid a worsening of outcomes, that a flatter Phillips curve would increase output volatility for a given level of inflation control, and that increased room for countercyclical fiscal policy seems to improve the trade-off between output and inflation variability.

4.1 More Firmly Anchored Expectations?

Overall, we interpret the results of several studies on this question as showing that credibility has improved during the inflation-reduction, inflation-control period.[12] Johnson (1998), for example, uses survey measures of expected inflation from 1984 to 1995 to examine the credibility of monetary policy across eighteen industrial countries, including Canada. He concludes that Canada and New Zealand have the most credible targets among the inflation targeting countries. Perrier (1998) uses survey data on expected inflation from the Conference Board of Canada. He concludes from these data that the Bank of Canada has developed increasing credibility over the inflation targeting period. These studies are based on formal regression analysis, but the flavor of their results can be captured by simply looking at the behavior of survey measures of inflation in the 1990s.

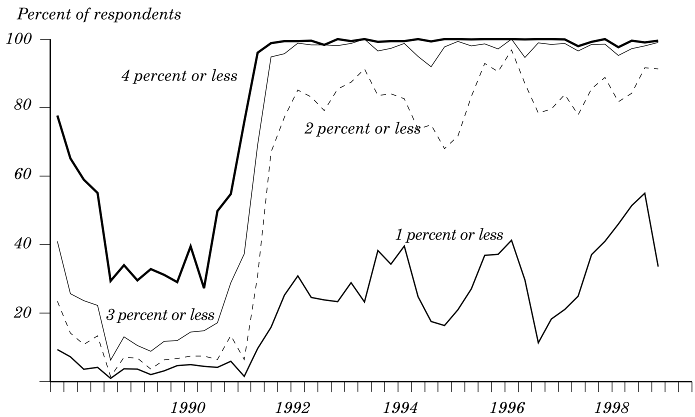
In the Conference Board of Canada's quarterly Survey of Forecasters for July 1999, the average forecast rates of inflation for 1999 and 2000 were 1.5 percent and 1.7 percent, respectively. The Conference Board also surveys businesses; from these surveys one can infer the distribution of expected year-to-year price increases over

12. Studies include Svensson (1994), Johnson (1997, 1998), Amano, Coletti, and Macklem, (1999), and Perrier (1998).

the next six months. Figure 5 (from data regularly available in the semiannual Monetary Policy Report) presents a time series of the percentage of business respondents who expected inflation to be at a certain level or less. As shown, close to 100 percent of the respondents expect Canadian inflation to be 3 percent (the upper band of the inflation range) or less over the near term. Longer-term inflation forecasts, reported by the Consensus Economics Inc. survey of forecasters, show a similar convergent trend. These forecasts suggest that longer-term (two, five, and ten years ahead) inflation expectations are in line with the midpoint (2 percent year-to-year) of the official inflation target band (figure 6).

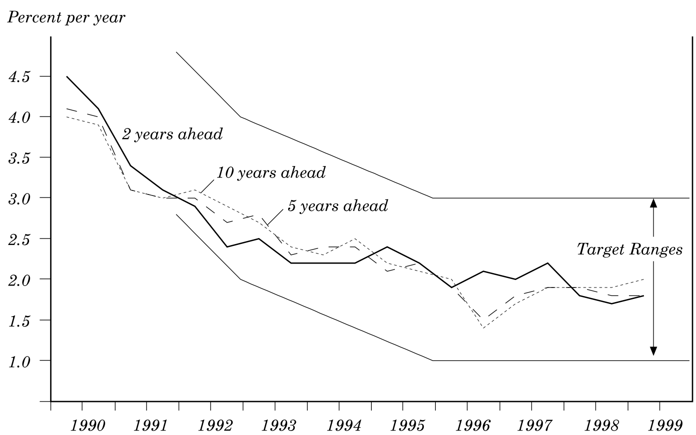
Other measures suggestive of reduced monetary uncertainty are reviewed in Amano, Coletti, and Macklem (1999). They include the dispersion of inflation forecasts across forecasters; the average deviation of inflation forecasts from the inflation target; the difference between the yield on Government of Canada long-term Real Return Bonds and nominal bonds of comparable maturity (a proxy for long-term inflation expectations, also regularly included in the *Monetary Policy Report*); and the length of debt contracts.

Figure 5. Distribution of Expected Price Increases in Canada Over the Next Six Months



Source: Conference Board of Canada, *Index of Business Confidence.*

Figure 6. Consensus Forecasts of CPI Inflation in Canada



Source: Consensus Economics Inc.

Amano, Coletti, and Macklem show that the effect of increasing credibility is to shift the policy frontier closer to the origin. However, they also find that a rule (defined by the degree of forward-lookingness on inflation and by the weight on the inflation gap term in a reaction function) that was on the frontier initially is unlikely to still be on the frontier when credibility is increased. One reason is that, with increased credibility, the forecasting horizon of private sector agents shortens, and the monetary authority should take this into account by shortening the horizon in its reaction function. There is also some indication that increasing the weight on the inflation gap improves the trade-off frontier.

4.2 Changes in the Slope of the Phillips Curve

For Canada, Dupasquier and Ricketts (1998a and b) consider five different models of asymmetric price adjustment and examine the testable implications of each on aggregate price data. They find a significant and positive relationship between the expected rate of inflation and the slope of the Phillips curve. However, when the Lucas model (the misperceptions or signal extraction model) and the menu-cost (or costly adjustment) model are considered together, the authors find it difficult to discriminate empirically between whether the flatter slope is due to a lower standard deviation of inflation, as implied by the Lucas model, or a lower mean of inflation, as implied by the menu-cost model. Nevertheless, their empirical evidence is suggestive of a flattening of the Phillips curve in an environment of low and stable inflation.

If the Phillips curve becomes flatter at lower rates of inflation, then disinflations that begin at lower inflation rates should be more costly. However, for demand shocks, a flatter Phillips curve means that inflation will move away from its target more slowly, so that the variance of inflation may fall. Debelle (1996) examines the last three Canadian disinflations and finds a negative relationship between the initial level of inflation and the resulting sacrifice ratio. In particular, he finds that the sacrifice ratio associated with the 1974-76 disinflation is 0.4 when the initial level of inflation was 11.5 percent; that the ratio for the 1981-85 disinflation is 2.0 when inflation was 12.9 percent; and that the sacrifice ratio of the 1990-93 disinflation is 3.5 when inflation was 5.3 percent.

For a given inflation expectations formation process, a flatter Phillips curve shifts the trade-off frontier (for inflation and output variability) such that output volatility is higher, especially for rules with a short forecasting horizon (Amano, Coletti, and Macklem, 1999). The latter is to be expected, as the stronger response of short-horizon rules, as opposed to longer-horizon rules, to prospective inflationary pressures creates more output variability. As the Phillips curve becomes flatter, the marginal cost, in terms of output variability, of better inflation control increases. Unlike changing credibility where there was a significant effect on the calibration of the rules, flattening the Phillips curve does not have a pronounced effect on which rules are good ones.

4.3 Changes in Fiscal Policy

From the mid-1970s to the mid-1990s, unsustainable structural deficits produced a steady increase in the ratio of net government debt to gross domestic product in Canada, from 5 percent in 1974 to 70 percent in 1996.[13] Over this period, Canada's net debt-to-GDP ratio moved from fourth highest among the Group of Seven major industrial countries to second highest.

13. Unless otherwise specified, net government debt is net consolidated debt across federal, provincial, and municipal governments as measured on a national accounts basis.

In response, Canadian fiscal authorities launched a variety of measures in the 1990s that were intended to first stabilize and eventually reduce the debt ratio. Beginning with its 1994–95 budget, the Canadian federal government set short-term deficit targets to provide economic agents and financial markets with an anchor for where fiscal policy was going. Over the five years in which the deficit targets have been in place, the Canadian federal government has consistently overachieved its announced target. In addition, six of Canada's ten provinces and both of its territories have enacted either legislation or constitutional constraints on government deficits, taxes, expenditure, or debt (see Millar, 1997). These measures (together with cyclical improvements in economic activity) have reduced the overall government deficit from approximately 8.0 percent of GDP in 1992 to a small surplus in 1998. The overall government net debt-to-GDP ratio in Canada has fallen, with further reductions expected. As a result, the constraints on the federal government's ability to behave countercyclically in the recent past are becoming less and less binding.

A more countercyclical fiscal policy allows a beneficial shift in the efficient policy frontier in the sense that, for a given level of inflation volatility, output volatility is lower (and vice versa) with only small changes in which monetary policy rules are most efficient. When fiscal policy can be more countercyclical, the beneficial effects for the efficient frontier arise from the ability to use automatic stabilizers, with their faster effects than monetary policy on aggregate demand, and from the complementarity of fiscal and monetary policy in responding to most shocks.

5. Some Concluding Remarks

This paper has discussed the Bank of Canada's current view of the monetary policy transmission mechanism in Canada and the research on which it is based, as well as some of the Bank's current and ongoing research on policy rules, or more accurately, policy reaction functions. The main objectives in the research on various elements of the monetary policy framework at the Bank of Canada is to find practical ways of addressing the major types of uncertainty in formulating monetary policy.

Uncertainty has become particularly important as a research and practical issue in recent years for several reasons. In Canada and in many other countries, there has been a shift in focus from how to achieve low inflation to how to conduct monetary policy in an environment of low and stable inflation. In such an environment the treatment of risks has become more symmetric. At the same time, increased international linkages have added to the uncertainties, but on the other hand, technological advances have increased economists' capability to deal with uncertainty.

The major types of uncertainty facing policymakers are uncertainty about shocks, uncertainty about parameters, uncertainty about data, and uncertainty about models. Shock uncertainty has three elements: additive (random) uncertainty, uncertainty about the persistence of shocks, and uncertainty surrounding the results from deterministic simulations implying the need for confidence bands. Parameter uncertainty reflects the fact that the responses of key variables to changes in the monetary policy instrument are not known with certainty. Data uncertainty results from the difficulty of measuring precisely such things as inflation and the output gap. Model uncertainty arises because the true model of the economy can never be known for sure.

At the Bank of Canada, experience and research have led the staff to identify three actions that can help policymakers deal with uncertainty and provide a sharper focus to discussions at key meetings on monetary policy:

- The main reaction function used should capture the policymakers' trade-off among the variance of inflation relative to target, the variance of the output gap, and the variance of (changes in) interest rates, to address parameter and data uncertainty. However, to take account of model uncertainty, an alternative reaction function of the Taylor-Ball-Srour type should be developed and used regularly.
- As to risks, it is helpful to follow a three-part approach. The first is to use confidence bands, based on past projection errors and simulation analysis, around inflation and output predictions in the base case and in alternative scenarios. The second is to develop alternative scenarios of key risks, which typically concern the size and persistence of additive shocks. The third is to develop no-change-in-policy scenarios (in which monetary conditions are held constant for two to four quarters), to highlight the cost of delaying policy actions.
- Other information should be reviewed for its consistency with the base case being presented for consideration by the policymakers.

In Canada this includes reports from the Bank's regional representatives on their reading of the economy, and the presentation of the implications for the path of monetary conditions of an alternative paradigm based on monetary and credit aggregates (to address model uncertainty).

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